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A FORTRAN SUBROUTINE FOR UNPACKING AND PACKING BINARY DATA

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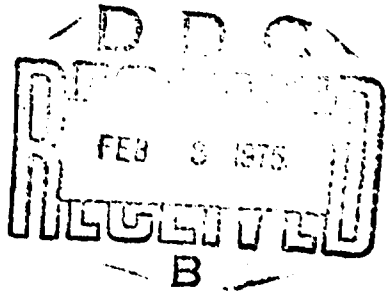

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Computer subroutine
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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This is a general purpose routine to unpack data stored in core in packed binary format or to pack binary data stored word for word in an array. The data must be stored in bytes which are a multiple of three bits in length with a minimum length of 3 bits and a maximum of 48 bits. It is useful for unpacking data read in packed binary form and sorting it into an array so as to be convenient for further processing by a Fortran program, or for preparing data from an array for writing out in a compact form, or possibly for intermediate storage of large arrays during execution of a program in order to save core space.

CONTENTS

1.0 IDENTIFICATION

1.1 Title

Unpacking and Packing of Binary Data

1.2 Identification Name

M2-NRL-THREEBIT

1.3 Classification Code

M2 - Data Handling, Conversion and/or Scaling

1.4 RCC Identification Number

M2002Ø00

1.5 Entry Points

THREEBIT, UNPACK, PACK

1.6 Programming Language

Language: 3600/3800 FØRTRAN
Routine Type: Subroutine
Operating System: DRUM SCØPE 2.1

1.7 Computer and Configuration

CDC 3800

1.8 Contributor or Programmer

Gary W. Phillips, Code 6603M, Consultant Staff,
Nuclear Sciences Division

1.9 Contributing Organization

NRL - Naval Research Laboratory,
Washington, D. C. 20375

1.10 Program Availability

1.10.1 Submittal: Program write-up, Fortran source deck, source listing

1.10.2 On File: RCC Program Library

1.11 Verification

The routine has been successfully tested in packing and unpacking binary data in bytes of length 3, 6, ..., 48 bits. In addition it has been used extensively to unpack data read in from 7-track tapes in binary format with 9, 12, 15 and 24 bit bytes.

1.12 Date

1 July 1974

2.0 PURPOSE

2.1 Description of the Routine

This is a general purpose routine to unpack data stored in core in packed binary format or to pack binary data stored word for word in an array. The data must be stored in bytes which are a multiple of three bits in length with a minimum length of 3 bits and a maximum of 48 bits.

It is useful for unpacking data read in packed binary form and sorting it into an array so as to be convenient for further processing by a Fortran program, or for preparing data from an array for writing out in a compact form, or possibly for intermediate storage of large arrays during execution of a program in order to save core space.

2.2 Problem Background

The program was originally written to unpack data read in from 7-track tapes in packed binary format of 9, 12, 15, and 24 bits in length. An existing program in the RCC Library, M2 UCSD BYTES, was found to be inapplicable as it could pack and unpack bytes in lengths only of 1, 6, 12, and 24 bits. Thus it could not be used for 9 bit and 15 bit lengths. Also, the logic was set up to handle only one byte at a time rather than handling the data as an array.

3.0 USAGE

3.1 Calling Sequence or Operational Procedure

```
UNPACK (NA,ARRAY,NT,TEMPLATE,NW,IWØRK,NBITS,NRETRN)
PACK (NA,ARRAY,NT,TEMPLATE,NW,IWØRK,NBITS,NRETRN)
```

3.2 Arguments, Parameters, and/or Initial Conditions

Entry UNPACK calls for unpacking data from ARRAY into TEMPLATE.

Entry PACK calls for packing data from TEMPLATE into ARRAY.

NA is the dimension of ARRAY.

ARRAY is the array used for the packed data.

NT is the dimension of TEMPLATE.

TEMPLATE is the array used for the unpacked data.

NW is the dimension of IWØRK and must be at least 2*NA.

IWØRK is working space used by the routine.

NBITS is the length in bits of the bytes.

NRETRN is a parameter returned by the routine to indicate the length of the unpacked or packed data returned. If negative, it indicates an error condition (see Section 3.5).

3.3 Space Required (Decimal and Octal)

3.3.1 Unique Storage:

777 octal (511 decimal) locations exclusive of computer system library functions

3.3.2 Common Blocks: None

3.3.3 Temporary Storage: IWØRK(NW)

3.4 Messages and Instructions to the Operator

None

3.5 Error Returns, Messages, and Codes

Several error messages are printed on the standard output unit. A negative value for NRETRN indicates the data was not processed and the reason is printed.

a. NBITS = (I3) IS NØT AN INTEGER MULTIPLE ØF 3
   Data not processed, NBITS must be evenly devisible by 3, NRETRN = -1.

b. NBITS = (I3) IS GREATER THAN 48
   Data not processed, NBITS cannot exceed 48, NRETRN = -2.

c. NW = (I5) MUST BE AT LEAST TWICE NA = (I5)
   Data not processed, NW is less than 2*NA, NRETRN = -3.

The calling program should take appropriate action when a negative NRETRN is received, e.g. terminate the program or go on to process the next data set.

3.6 Informative Messages to the User

The following messages indicate only part of the data could be processed.

a. NUMBER ØF BYTES = (I5) EXCEEDS NT = (I5)
   NT BYTES WILL BE PROCESSED
   ARRAY could not be completely unpacked because NT was less than (NA*48)/NBITS, the total number of bytes of length NBITS contained in ARRAY.

b. PACKED LENGTH = (I10) EXCEEDS NA = (I5)
   THE FIRST (I5) BYTES WILL BE PROCESSED
   NT bytes of length NBITS would occupy a packed length of (NT*NBITS+47)/48 words, which exceeds NA. Only (NA*48)/NBITS bytes will be packed.

Upon return from the above two cases or upon a normal return from a call to UNPACK or PACK, NRETRN will contain the length in words of the unpacked (TEMPLATE) or packed (ARRAY) data, respectively. Partial bytes

will not be processed. If the packed data ends with a partial word it will be zero filled on the right. Elements of TEMPLATE or ARRAY with index greater than NRETRN will contain their previous values. Consequently, after return from THREEBIT the calling program should take care not to process elements of the data with index greater than NRETRN.

3.7 Input

None

3.8 Output

None other than the output described in Sections 3.5 and 3.6.

3.9 Formats

Not applicable

3.10 External Routines and Symbols

XMØDF

3.11 Timing

No timing estimates were made; the timing depends on the data length and byte length. The example in Section 7.0 took five seconds, excluding compilation time.

3.12 Accuracy

Not applicable

3.13 Cautions to Users

See Sections 3.5 and 3.6

3.14 Program Deck Structure

$^{7}_{9}$JØB card

$^{7}_{9}$FTN card

main program deck (includes call to PACK or UNPACK)

SUBRØUTINE THREEBIT

SCØPE card

$^{7}_{9}$LØAD card

$^{7}_{9}$RUN card

Data (if any)

EØF

3.15 References - Literature - Appendices

None

4.0 METHOD OR ALGORITHM

The Fortran statements DECØDE and ENCØDE are used in UNPACK to go from a packed binary format in ARRAY to a packed BCD format in IWØRK to an unpacked one byte per word format in TEMPLATE. For entry PACK the reverse of the above is done. Variable formats and variable dimensions are used to make the routine as general as possible.

5.0 SOURCE LANGUAGE LISTING

```
      SUBROUTINE THREEBIT(NA,ARRAY,NT,TEMPLATE,NW,IWORK,NBITS,NRETRN)
C
C  IDENT NUMBER -  M2002000
C  TITLE - UNPACKING AND PACKING OF BINARY DATA
C  IDENT NAME - M2 NRL THREEBIT
C  LANGUAGE - 3600/3800 FORTRAN
C  COMPUTER - CDC 3800
C  CONTRIBUTOR - GARY W. PHILLIPS, CODE 6603M
C                CONSULTANT STAFF
C                NUCLEAR SCIENCES DIVISION
C  ORGANIZATION - NAVAL RESEARCH LABORATORY
C                 WASHINGTON, D.C. 20375
C
C  DATE - 14 JUNE 1974
C
C  GENERAL PURPOSE PROGRAM TO PACK AND UNPACK BINARY DATA IN BYTES
C  WHICH ARE A MULTIPLE OF THREE BITS IN LENGTH, UP TO 24 BITS MAXIMUM.
C  ENTRY UNPACK OPERATES ON PACKED DATA IN ARRAY, DIMENSION NA, AND
C  RETURNS THE UNPACKED DATA IN TEMPLATE, DIMENSION NT.
C  ENTRY PACK WILL PACK DATA FROM TEMPLATE INTO ARRAY.
C  A WORK AREA IWORK IS REQUIRED OF DIMENSION NW AT LEAST TWICE NA.
C
      DIMENSION ARRAY(NA),TEMPLATE(NT),IWORK(NW),IFORM(2),JFORM(2)
      TYPE INTEGER ARRAY,TEMPLATE
C
      ENTRY UNPACK
      NPACK=0
      GO TO 10
C
      ENTRY PACK
      NPACK=1
C
   10 IF(MOD(NBITS,3)) 20,30
   20 PRINT 21,NBITS
   21 FORMAT(*0NBITS =*I3* IS NOT AN INTEGER MULTIPLE OF 3*)
      NRETRN=-1
      RETURN
C
   30 K=NBITS/3
      IF(NBITS.LT.49) GO TO 40
      PRINT 31,NBITS
   31 FORMAT(*0NBITS =*I3* IS GREATER THAN 48*)
      NRETRN=-2
      RETURN
C
   40 IF(NA.LE.NW/2) GO TO 50
      PRINT 41,NW,NA
   41 FORMAT(*0NW =*I5* MUST BE AT LEAST TWICE NA =*I5)
      NRETRN=-3
      RETURN
C
   50 IF(NPACK) GO TO 60
      NB=(NA*48)/NBITS
      IF(NB.LE.NT) GO TO 100
      PRINT 51,NB,NT
   51 FORMAT(*0NUMBER OF BYTES =*I5* EXCEEDS NT =*I5/
     * * NT BYTES WILL BE PROCESSED*)
```

```
      NB=NT                                                          570
      GO TO 100                                                      580
C                                                                    590
   60 NB=NT                                                          600
      NC=(NB*NBITS+47)/48                                            610
      IF(NC.LE.NA) GO TO 100                                         620
      NB=(NA*48)/NBITS                                               630
      PRINT 61,NC,NA,NB                                              640
   61 FORMAT(*0PACKED LENGTH =*I10* EXCEEDS NA =*I5/                 650
     * * THE FIRST*I5* BYTES WILL BE PROCESSED*)                     660
      NC=(NB*NBITS+47)/48                                            670
C                                                                    680
  100 IF(NB-256) 110,110,120                                         690
  110 IWL=16*NB                                                      700
      ENCODE(16,101,JFORM) NB                                        710
  101 FORMAT(*(*I4*016)*)                                            720
      GO TO 130                                                      730
  120 IA=NB/256                                                      740
      IF(MOD(NB,256)) IA=IA+1                                        750
      IWL=IA*4096                                                    760
      ENCODE(16,121,JFORM) IA                                        770
  121 FORMAT(*(*I2*(2560) ))*)                                       780
  130 IF(NB-256) 150,140,140                                         790
  140 IWB=NB*K                                                       800
      ENCODE(16,141,IFORM) NB,K                                      810
  141 FORMAT(*(*I4*0*I2*)*)                                          820
      GO TO 200                                                      830
  150 IB=NB/256                                                      840
      IF(MOD(NB,256)) IB=IB+1                                        850
      IWB=IB*256*K                                                   860
      ENCODE(16,151,IFORM) IB,K                                      870
  151 FORMAT(*(*I2*(2560*I2*))*)                                     880
C                                                                    890
  200 IF(NPACK) 240,210                                              900
  210 ENCODE(IWL,JFORM,IWORK)(ARRAY(I),I=1,NA)                       910
  220 DECODE(IWB,IFORM,IWORK)(TEMPLATE(I),I=1,NM)                    920
      NRETRN=NB                                                      930
      RETURN                                                         940
C                                                                    950
  240 NJ=2*NC                                                        960
      IWORK(NJ)=0                                                    970
  245 ENCODE(IWB,IFORM,IWORK)(TEMPLATE(I),I=1,NM)                    980
  250 DECODE(IWL,JFORM,IWORK)(ARRAY(I),I=1,NC)                       990
      NRETRN=NC                                                     1000
C                                                                   1010
      END                                                           1020
```

6.0 COMPARISON

The present routine will handle packed arrays with byte lengths of any multiple of three bits up to 48 bits. The routine M2 UCSD BYTES in the RCC Program Library will handle byte lengths of 1, 6, 12, and 24 bits, but only one byte at a time.

Except for the one bit case, it is usually preferable to unpack the data before further processing rather than handling it byte by byte.

7.0 TEST METHOD AND RESULTS

A test program, PCKUNPCK, was written to unpack from ARRAY to TEMPLATE and then pack from TEMPLATE into ARRAY, for NBITS equal to 6, 18, and 30. The listing of PCKUNPCK and the results follow.

```
      PROGRAM PCKUNPCK
      DIMENSION ARRAY(4),BRRAY(4),TEMPLATE(20),IWORK(8)
      DATA (ARRAY=4(1234567012345670))/
     *     (NA=4),(NT=20),(NW=8),(NB=4)
      TYPE INTEGER ARRAY,BRRAY,TEMPLATE
      DO 20 I=6,30,12
      NBITS=I
      NCHAR=NBITS/3
      PRINT 101,NBITS,NCHAR
  101 FORMAT(//* - - - - NBITS =*I4*  NCHAR =*I3* - - - -*)
      PRINT 10, ARRAY
   10 FORMAT(*0ARRAY*/1X4(1X016))
      DO 110 J=1,NT
  110 TEMPLATE(J)=0
      CALL UNPACK(NA,ARRAY,NT,TEMPLATE,NW,IWORK,NBITS,NL)
      PRINT 11,NL,(TEMPLATE(J),J=1,NL)
   11 FORMAT(*0TEMPLATE  LENGTH =*I3/(1X4(1X016)))
      DO 12 J=1,NB
   12 BRRAY(J)=0
      CALL PACK(NA,BRRAY,NT,TEMPLATE,NW,IWORK,NBITS,NL)
   20 PRINT 13,NL,(BRRAY(J),J=1,NL)
   13 FORMAT(*0BRRAY  LENGTH =*I3/1X4(1X016))
      END
```

```
- - - - NBITS =   6  NCHAR =  2 - - - -

ARRAY
 1234567012345670 1234567012345670 1234567012345670 1234567012345670

NUMBER OF BYTES =   32 EXCEEDS NT =   20
NT BYTES WILL BE PROCESSED

TEMPLATE  LENGTH = 20
 0000000000000012 0000000000000034 0000000000000056 0000000000000070
 0000000000000012 0000000000000034 0000000000000056 0000000000000070
 0000000000000012 0000000000000034 0000000000000056 0000000000000070
 0000000000000012 0000000000000034 0000000000000056 0000000000000070
 0000000000000012 0000000000000034 0000000000000056 0000000000000070

BRRAY  LENGTH =  3
 1234567012345670 1234567012345670 1234567000000000


- - - - NBITS =  18  NCHAR =  6 - - - -

ARRAY
 1234567012345670 1234567012345670 1234567012345670 1234567012345670

TEMPLATE  LENGTH = 10
 0000000000123456 0000000000701234 0000000000567012 0000000000345670
 0000000000123456 0000000000701234 0000000000567012 0000000000345670
 0000000000123456 0000000000701234

PACKED LENGTH =         8 EXCEEDS NA =    4
THE FIRST   10 BYTES WILL BE PROCESSED

BRRAY  LENGTH =  4
 1234567012345670 1234567012345670 1234567012345670 1234567012340000


- - - - NBITS =  30  NCHAR = 10 - - - -

ARRAY
 1234567012345670 1234567012345670 1234567012345670 1234567012345670

TEMPLATE  LENGTH =  6
 0000001234567012 0000003456701234 0000005670123456 0000007012345670
 0000001234567012 0000003456701234

PACKED LENGTH =        13 EXCEEDS NA =    4
THE FIRST    6 BYTES WILL BE PROCESSED

BRRAY  LENGTH =  4
 1234567012345670 1234567012345670 1234567012345670 1234567012340000
```